CLAIMS

1. A fuel cell system, comprising:

a fuel cell structure comprising at least one fuel cell;

at least one pnp bipolar junction transistor having a base, an emitter and a collector, the transistor coupled to respond to a voltage across the fuel cell structure; and

an alarm circuit coupled to the collector of the transistor.

2. The fuel cell system of claim 1, further comprising:

an optoisolator having a first terminal, a second terminal and a switching terminal, the first terminal of the optoisolator coupled to a ground, the second terminal coupled to a positive reference voltage source that is positive with respect to the ground, the switching terminal of the optoisolator coupled between the collector of the transistor and a negative reference voltage source that has a voltage that is less than a lowest voltage of the fuel cell structure.

3. The fuel cell system of claim 1, further comprising:

a first base resistance coupled between the fuel cell structure and the base of the transistor; and

a second base resistance coupled between the fuel cell structure and the base of the transistor.

4. The fuel cell system of claim 1, further comprising:

a first optoisolator resistance coupled between the switching terminal of the optoisolator and the negative reference voltage supply; and

a second optoisolator resistance coupled between the second terminal of the optoisolator and the positive reference voltage supply.

5. The fuel cell system of claim 1 wherein the fuel cell structure includes a plurality of fuel cells electrically connected to one another in series.

6. The fuel cell system of claim 1 wherein the fuel cell structure includes a pair of solid polymer fuel cells electrically connected to one another in series.

7. A fuel cell system, comprising:

a fuel cell stack comprising at least two fuel cell structures, each fuel cell structure comprising a pair of fuel cells;

for each fuel cell structure, a respective pnp bipolar junction transistor, comprising a base, an emitter and a collector, and coupled to respond to a voltage across the fuel cell structure, and

for each fuel cell structure, a fuel cell pair optoisolator having an output including a first terminal, a second terminal, and an input including a switching terminal, the first terminal coupled to a ground, the second terminal coupled to a positive reference voltage that is positive with respect to the ground, and the switching terminal coupled between the collector of the transistor and a negative reference voltage that has a voltage less than a lowest voltage of the respective fuel cell structure.

8. The fuel cell system of claim 7, further comprising:

for each of the fuel cell structures, a fuel cell structure AND circuit, ANDING the outputs of each of the fuel cell pair optoisolators of the respective fuel cell structures.

9. The fuel cell system of claim 7, further comprising:

for each fuel cell structure, a respective fuel cell structure optoisolator having an output including a first terminal and a second terminal and an input including a switching terminal, wherein for each fuel cell structure, the outputs of each of the fuel cell pair optoisolators are coupled in series to one another and are coupled to the negative reference voltage through the switching terminal of the respective fuel cell structure optoisolator, the

outputs of the respective fuel cell structure optoisolators being coupled in series with one another.

10. The fuel cell system of claim 7, further comprising:

for each of the fuel cell structures, a fuel cell structure AND circuit ANDING the outputs of each of the fuel cell pair optoisolators of the respective fuel cell structures; and

a fuel cell stack AND circuit, ANDING each of the outputs of the respective fuel cell structure AND circuits.

11. The fuel cell system of claim 7, further comprising:

for each fuel cell structure, a respective fuel cell structure optoisolator having an output including a first terminal and a second terminal and an input including a switching terminal, wherein for each fuel cell structure, the outputs of each of the fuel cell pair optoisolators are coupled in series to one another and are coupled to the negative reference voltage through the switching terminal of the respective fuel cell structure optoisolator, the outputs of the respective fuel cell structure optoisolators being coupled in series with one another; and

a fuel cell stack optoisolator having an output including a first terminal and a second terminal and an input including a switching terminal, the second terminal of a final one of the fuel cell structure optoisolators coupled to the negative reference voltage through the switching terminal of the fuel cell stack optoisolator.

12. A monitoring system for monitoring fuel cells, comprising:

a transistor having a first terminal, a second terminal, and a switching terminal, the first terminal and the switching terminal of the transistor couplable to respond to a voltage across at least two fuel cells; and

an optoisolator having a first terminal, a second terminal and a switching terminal, the first terminal of the optoisolator coupled to a ground reference voltage, the switching terminal coupled between the second terminal of the transistor and a first reference voltage

below the ground reference voltage for control by the transistor in response to the voltage across the fuel cells, the second terminal of the optoisolator coupled to a second reference voltage above the ground reference voltage to produce a digital signal on the second terminal corresponding to an operational status of the fuel cells.

13. The monitoring system of claim 12 wherein the transistor is a pnp bipolar junction transistor, the first terminal forming an emitter, the second terminal forming a collector, and the switching terminal forming a base of the pnp transistor.

14. The monitoring system of claim 12 wherein the transistor is couplable to a pair of fuel cells to respond to the voltage across the two fuel cells.

15. The monitoring system of claim 12, further comprising:

a connector including a first lead coupled to the first terminal of the transistor to couplable the first terminal of the transistor to one of the fuel cells, and a second lead coupled to the switching terminal of the transistor to couple the switching terminal to another of the fuel cells.

16. A monitoring system for monitoring fuel cells, comprising:

a set of digitizing switches, each of the digitizing switches having a first terminal coupled to a ground, a second terminal coupled to a positive reference voltage with respect to the ground, and a switching terminal coupled to a negative reference voltage with respect to ground, each of the digitizing switches responsive to a first defined potential difference between the first terminal and the switching terminal of the respective digitizing switch; and

a set of triggering switches, each of the triggering switches having a first terminal and a switching terminal couplable across a respective one of a number of fuel cell structures, and a second terminal coupled to the switching terminal of a respective one of the digitizing switches, each of the triggering switches responsive to a second defined potential difference between the first terminal and the switching terminal of the triggering switch.

17. The monitoring system of claim 16 wherein the set of digitizing switches comprises a number of optoisolators.

18. The monitoring system of claim 16 wherein the set of triggering switches comprises a number of pnp bipolar junction transistors, the first terminal forming an emitter, the second terminal forming a collector and the switching terminal forming a base of the respective pnp bipolar junction transistor.

19. The monitoring system of claim 16 wherein the first switch comprises a bipolar junction transistor and the second defined potential difference is approximately 0.6 volts.

20. The monitoring system of claim 16, further comprising:

a connector having a first set of leads coupled to respective ones of the first terminals of the triggering switches and a second set of leads coupled to respective ones of the switching terminals of the triggering switches.

21. The monitoring system of claim 16 wherein there is one triggering switch for each pair of fuel cells in the fuel cell structure.

22. The monitoring system of claim 16 wherein a number of the digitizing switches are coupled in series to provide a single digital signal.

23. The monitoring system of claim 16 wherein a number of subsets of the digitizing switches are coupled in series to provide a single digital signal for each subset, and further comprising:

an number of AND circuits coupling the digital signals from the subsets of the digitizing switches to provide a single digital signal for the set of digitizing switches.

24. A method of monitoring fuel cells in a fuel cell structure, comprising:

coupling a first terminal and a switching terminal of a transistor across a pair of fuel cells electrically connected in series forming a fuel cell structure;

producing a first indication when the voltage across the fuel cell structure is greater than a threshold voltage; and

producing a second indication, different from the first indication, when the voltage across the fuel cell structure is not greater than the threshold voltage.

25. The method of claim 24, further comprising:

coupling a second terminal of the transistor to an optoisolator; and

activating the optoisolator when current is passing between the first and the second terminals of the transistor and deactivating the optoisolator when current is not passing between the first and the second terminals of the transistor.

26. The method of claim 24 wherein coupling a first terminal and a switching terminal of a transistor across a pair of fuel cells forming a fuel cell structure, includes:

coupling the first terminal to a cathode of one of the fuel cells of the fuel cell structure and coupling the switching terminal to the anode of the other fuel cell of the fuel cell structure.

27. The method of claim 24 wherein coupling a first terminal and a switching terminal of a transistor across a pair of fuel cells forming a fuel cell structure, includes:

coupling the first terminal to a cathode of one of the fuel cells in the fuel cell structure and coupling the switching terminal to an anode of the other fuel cell of the fuel cell structure through a first resistor and to the cathode of the fuel cell structure through a second resistor.

28. The method of claim 24 wherein coupling a first terminal and a switching terminal of a transistor across a pair of fuel cells forming a fuel cell structure, includes:

coupling the first terminal to a cathode of the first of the fuel cells in the fuel cell structure and coupling the switching terminal to an anode of the second fuel cell of the fuel cell structure through a first resistor and to the cathode of the first fuel cell through a second resistor;

selecting a first resistance of the first resistor and a second resistance of the second resistance to set the threshold voltage to a voltage in a range of 0.8 volts to 0.85 volts.

29. The method of claim 24 wherein producing a first indication when the voltage across the fuel cell structure is greater than a threshold voltage includes producing a first voltage level corresponding to one of an ON and an OFF indication and wherein producing a second indication, different from the first indication, when the voltage of the fuel cell structure is not greater than the threshold voltage includes producing a second voltage level corresponding to the other of the ON and the OFF indication.

30. A method of monitoring fuel cells in a fuel cell stack, comprising:

monitoring a voltage across a first set of at least two fuel cells in the fuel cell stack with at least a first transistor;

simultaneously monitoring a voltage across a second set of at least two fuel cells in the fuel cell stack with at least a second transistor;

producing a first indication when the voltage across each of the first and the second sets of at least two fuel cells in the fuel cell stack is greater than a threshold voltage; and

producing a second indication when the voltage across any of the first and the second sets of at least two fuel cells in the fuel cell stack is not greater than the threshold voltage.

31. The method of claim 30 wherein monitoring a voltage across a first set of at least two fuel cells includes detecting a current flow from the first transistor, the first transistor having a first terminal and a switching terminal coupled to the first set of at least two fuel cells; and wherein simultaneously monitoring a voltage across a second set of at least two fuel cells

includes detecting a current flow from the second transistor, the second transistor having a first terminal and a switching terminal coupled to the second set of at least two fuel cells.

32. A method of monitoring fuel cells in a fuel cell stack, comprising:

monitoring a voltage across a first set of at least two fuel cells in the fuel cell stack with at least a first transistor and a first optoisolator;

simultaneously monitoring a voltage across a second set of at least two fuel cells in the fuel cell stack with at least a second transistor and a second optoisolator;

producing a first indication when the voltage across each of the first and the second sets of at least two fuel cells in the fuel cell stack is greater than a threshold voltage; and

producing a second indication when the voltage across any of the first and the second sets of at least two fuel cells in the fuel cell stack is not greater than the threshold voltage.

33. The method of claim 32 wherein monitoring a voltage across a first set of at least two fuel cells includes detecting a current flow from an output side of the first optoisolator, the first transistor having a first terminal and a switching terminal coupled to the first set of at least two fuel cells, and a second terminal coupled to an input side of the first optoisolator; and wherein simultaneously monitoring a voltage across a second set of at least two fuel cells includes detecting a current flow from an output side of the second optoisolator, the second transistor having a first terminal and a switching terminal coupled to the second set of at least two fuel cells, and a second terminal coupled to an input side of the second optoisolator.